ENERGY EFFICIENCY IN BUILDINGS IN SWITZERLAND

(REPORT ON THE PROJECT OF THE SWISS SHADOW GROUP)

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Summary

In Switzerland, a culture for low energy concepts is established. The procedure for quality assurance during design, elaboration, construction, and acceptance phases is based on detailed technical checklists. These procedures are similar to the Initial-Cx type, but we do not call them Cx activities – it is just standard procedure in Switzerland. It is often up to the operator to detect and prove that there is a lack of performance. However, in many cases the management overestimates the operator's competence for many reasons and is not aware of the high risk that the HVAC-systems may run above the economic optimum point. Taking into consideration the operator's (Facility Manager, FM) sphere of activities – structured by the change, risk, resources, and knowledge management – helps to give a structure to tasks and workflow. This leads to a process-oriented operation of buildings.

STANDARD REQUIREMENTS IN SWITZERLAND

In the past 25 years, Switzerland has realized several national programs with the political objective to nation wide increase the awareness of energy and ecological matters, to encourage activities for energy savings and for increasing energy efficiency in buildings. All these programs where based on specific objectives shown below:

Duration	Topic	Objective	Outcome
1973-1985	Campaign for saving fossil fuel energy	- Energy savings is a matter of national concern - Detailed instruction for architects and engineers on how to proceed for e-savings in projects - Develop basic tools and demonstration sites - Subsidy on e-saving projects	- Basic tools and general procedure in e-saving projects - E-saving projects in private and public buildings nation-wide - Energy Standards and Energy Legislations

Duration	Topic	Objective	Outcome
1986-1992	Campaign for saving electricity	-- Detailed instruction for architects and engineers on how to proceed for electricity savings in projects - Increase the general sensibility for low use electrical equipment in house and office - Projects to develop and encourage application of photovoltaic and wind energy - Develop basic tools and demonstration sites - Subsidy of photovoltaic and heat pump projects	- Basic tools and general procedure in e-saving projects - National data bank of home and office equipments (similar to the Energy Star) - Energy Standards and Energy Legislations are revised to a better level of e-efficiency
1993 - 2000	Campaign for increasing energy efficiency in a broad sense	- Public and private projects to increase the energy efficiency in both large and small buildings - Projects to develop systems for saving energy in traffic and transportation - Projects to develop methods to increase energy efficiency in industry, trade and administration by optimum operation of the HVAC-equipment - Develop tools and demonstration sites	- New standards for energy related regulations in buildings (e.g. Minergie, passive house standards, etc.) - Standards for final check and acceptance of HVAC-equipment - New regulations in Energy legislation - Mobility (car sharing nation-wide)
2001 - 2007	Based on new CO2 Legislation: Delegate activities for energy savings to the private sector	- Create energy agencies financed mainly by the private sector. Their activities are aimed at reducing the CO2 consumption in order to reduce or avoid the coming CO2 taxes which will be introduced by law	- Reach level of Kyoto Protocol for CO2

During this period, the standards and legislation dealing with energy efficiency in buildings were developed step-by-step, according to the acceptance registered and the results experienced in these national programs. Today we have reached a high level of good practice for energy efficiency in buildings, based on standards developed by the associations and legislations. An owner can choose between three levels of standard for his project; for the permission of construction, he needs to fulfil the following standard requirements:

Category of building	Maximum accepted heat load [MJ/m^{2}a]		
	Standard requirement (SIA 380/1)	Minergie Standard	Minergie P
Apartment house	197	158	39
Detached house	225	180	45
Administration	147	118	29
School	198	158	40
Shopping	150	120	30
Restaurant	230	184	46
Meeting place	213	170	43
Hospital	180	144	36
Industry	155	124	31
Warehouse	144	115	29
Sports centre	159	127	32
Indoor swimming pool	200	120	40

Today, most of the new public buildings are designed to fulfil the Minergie Standard requirements. In the private sector, the Minergie Standard is being realized more often. Owners, who receive a Minergie Label, may also profit because of their efforts by receiving bank credits and tax savings. Finally, buildings with a Minergie Label have a better market position for renting or selling. After all, it is up to the owner to decide whether he wants to reach the Minergie level, or if he stays with the standard requirements in his new project.

FUNCTIONAL TESTS AND ACCEPTANCE CHECKS

To reach the Minergie Label, there are more criteria's to fulfil than just the mentioned maximum heat load:

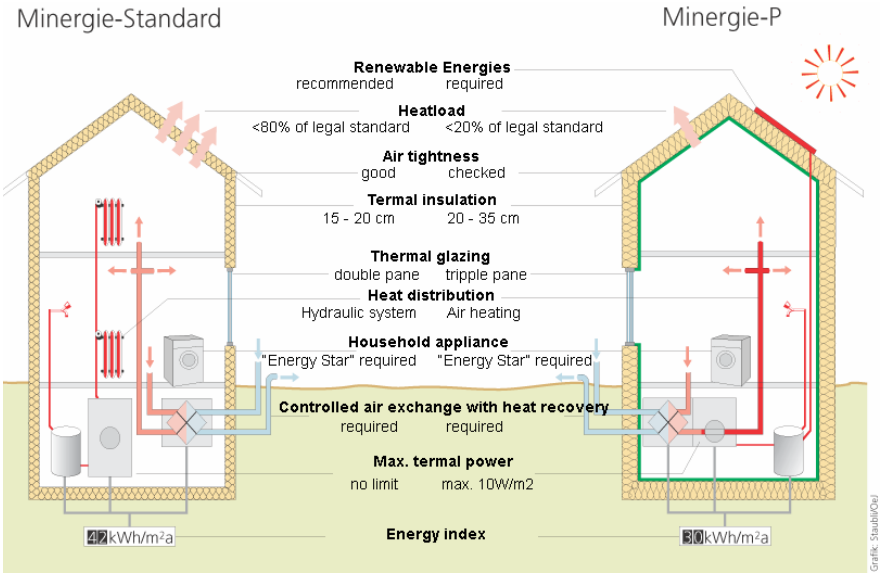
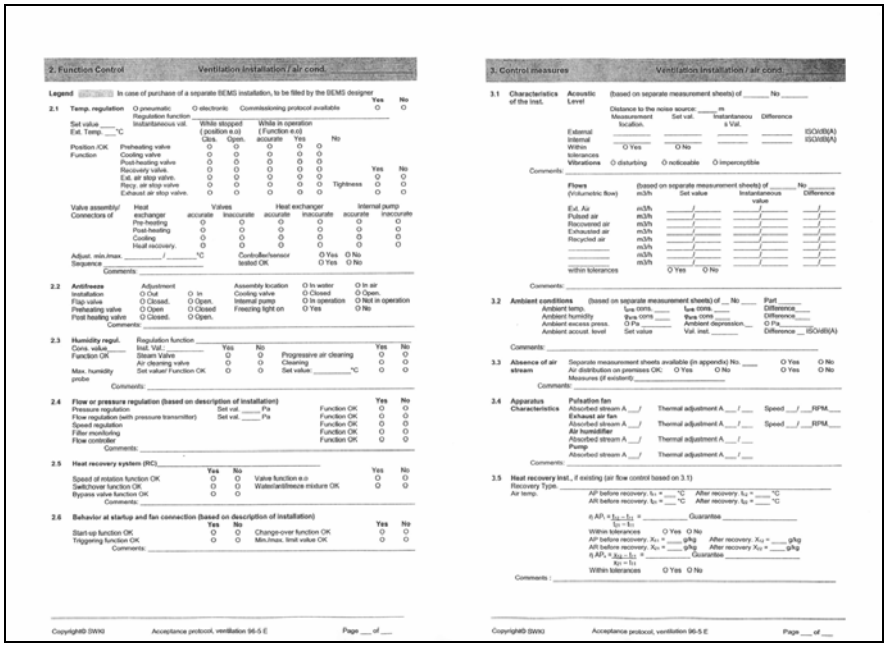


Figure 1. Requirements of Minergie Standard and Minergie P

It is good practice for all professionals in Switzerland to fulfil one of the requirement levels according to the owner's program. During the design phase for the permission of construction, the designer has to state all details of how he intends to realize his project within the limits given by the standards. During the construction phase, it is up to the designer to check the realization according to the accepted design statement. There is no given test procedure for the realization phase. Finally, the designer has to proceed to active functional testing and balancing of the HVAC-system at the end of the realization. Today it is common to use for these tests the SWKI-checklists, especially in public projects.



2. Function Control — Ventilation installation / air cond.

Legend: In case of purchase of a separate BEMS installation, to be filled by the BEMS designer

2.1 Temp. regulation — O pneumatic O electronic — Commissioning protocol available — Yes O / No O

Set value ____ Ext. Temp. ___°C — Regulation function: _____ — Instantaneous val.

Position /OK. Function	While stopped (position e.o) Clos.	Open.	While in operation (Function e.o) accurate	Yes	No
Preheating valve	O	O	O	O	
Cooling valve	O	O	O	O	
Post-heating valve	O	O	O	O	
Recovery valve	O	O	O	O	
Ext. air stop valve.	O	O	O	O	
Recy. air stop valve	O	O	O	O	Tightness
Exhaust air stop valve.	O	O	O	O	

Valve assembly/ Connectors of	Heat exchanger accurate	Valves Inaccurate	Heat exchanger accurate	Heat exchanger Inaccurate	Internal pump accurate	Internal pump Inaccurate
Pre-heating	O	O	O	O	O	O
Post-heating	O	O	O	O	O	O
Cooling	O	O	O	O	O	O
Heat recovery.	O	O	O	O	O	O

Adjust. min./max. _____/_____°C — Controller/sensor tested OK — O Yes O No

Sequence _____ — Comments: _____

2.2 Antifreeze — Adjustment

Installation			Assembly location		
	O Out	O In	Cooling valve	O Closed	O In air O Open.
Flap valve	O Closed.	O Open.	Internal pump	O In operation	O Not in operation
Preheating valve	O Open	O Closed	Freezing light on	O Yes	O No
Post heating valve	O Closed.	O Open.			

Comments: _____

2.3 Humidity regul. — Regulation function _____

Cons. value____ Function OK	Ins. Val.: _____ Steam Valve	Yes	No		Yes	No
	Air cleaning valve	O	O	Progressive air cleaning	O	O
Max. humidity probe	Set value/ Function OK	O	O	Cleaning Set value: _____°C	O	O

Comments: _____

2.4 Flow or pressure regulation (based on description of installation)

			Yes	No
Pressure regulation	Set val. ____ Pa	Function OK	O	O
Flow regulation (with pressure transmitter)	Set val. ____ Pa	Function OK	O	O
Speed regulation		Function OK	O	O
Filter monitoring		Function OK	O	O
Flow controller		Function OK	O	O

Comments: _____

2.5 Heat recovery system (RC)_____

	Yes	No		Yes	No
Speed of rotation function OK	O	O	Valve function e.o	O	O
Switchover function OK	O	O	Water/antifreeze mixture OK	O	O
Bypass valve function OK	O	O			

Comments: _____

2.6 Behavior at startup and fan connection (based on description of installation)

	Yes	No		Yes	No
Start-up function OK	O	O	Change-over function OK	O	O
Triggering function OK	O	O	Min./max. limit value OK	O	O

Comments: _____

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3. Control measures — Ventilation installation / air cond.

3.1 Characteristics of the inst. — Acoustic Level (based on separate measurement sheets) of _____ No _____

Distance to the noise source: _____ m

	Measurement location.	Set val.	Instantaneou s Val.	Difference	
External	_____	_____	_____	_____	ISO/dB(A)
Internal	_____	_____	_____	_____	ISO/dB(A)
Within tolerances	O Yes	O No			

Vibrations O disturbing O noticeable O imperceptible

Comments: _____

Flows (based on separate measurement sheets) of _____ No _____

(Volumetric flow)	m3/h	Set value	Instantaneous value	Difference
Ext. Air	m3/h	_____/_____	_____/_____	_____/_____
Pulsed air	m3/h	_____/_____	_____/_____	_____/_____
Recovered air	m3/h	_____/_____	_____/_____	_____/_____
Exhausted air	m3/h	_____/_____	_____/_____	_____/_____
Recycled air	m3/h	_____/_____	_____/_____	_____/_____
_____	m3/h	_____/_____	_____/_____	_____/_____
_____	m3/h	_____/_____	_____/_____	_____/_____
_____	m3/h	_____/_____	_____/_____	_____/_____

within tolerances O Yes O No

Comments: _____

3.2 Ambient conditions (based on separate measurement sheets) of __ No ____ Part ____

Ambient temp.	t_{amb} comb. _____	t_{amb} comb. _____	Difference____
Ambient humidity	φ_{amb} comb. _____	φ_{amb} comb. _____	Difference____
Ambient excess press.	O Pa _____	Ambient depression __	O Pa_____
Ambient accust. level	Set value	Val. inst. _____	Difference __ ISO/dB(A)

Comments: _____

3.3 Absence of air stream — Separate measurement sheets available (in appendix) No. ____ O Yes O No

Air distribution on premises OK: O Yes O No — O Yes O No

Measures (if existent): _____

Comments: _____

3.4 Apparatus Characteristics — Pulsation fan

Absorbed stream A ___/___ Thermal adjustment A ___/___ Speed ___/___RPM___

Exhaust air fan

Absorbed stream A ___/___ Thermal adjustment A ___/___ Speed ___/___RPM___

Air humidifier

Absorbed stream A ___/___ Thermal adjustment A ___/___

Pump

Absorbed stream A ___/___ Thermal adjustment A ___/___

Comments: _____

3.5 Heat recovery inst., if existing (air flow control based on 3.1)

Recovery Type _____

Air temp. — AP before recovery. t_{A1} = ___ °C After recovery. t_{A2} = ___ °C

AR before recovery. t_{E1} = ___ °C After recovery. t_{E2} = ___ °C

η AP, = $\frac{t_{A2}-t_{A1}}{t_{E1}-t_{A1}}$ = _____ Guarantee _____

Within tolerances O Yes O No

AP before recovery. X_{A1} = ____ g/kg After recovery. X_{A2} = ____ g/kg

AR before recovery. X_{E1} = ____ g/kg After recovery X_{E2} = ____ g/kg

η AP, = $\frac{x_{A2}-x_{A1}}{x_{E1}-x_{A1}}$ = _____ Guarantee _____

Within tolerances O Yes O No

Comments : _____

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Figure 2. Checklist for Ventilation system (extract)

At the acceptance of the building, the owner and the legal authority generally accept these checklists as the as-built document of the new HVAC systems; there will also be the labelling process for those with Minergie Standard or Minergie P. For this labelling process, the designer has to establish a separate checklist and the Minergie authority will check its correctness.

In Switzerland, we do not call these checks Cx activities and we have no Cx authority. It is simply the standard procedure and normal business practice for the designer. He is responsible for the fulfilment of the minimal requirements according to the standards prescribed by law, respectively as fixed by the owner in his OPR. The public authority or the owner may check the fulfilment at the end of the construction. If during this check any difference is identified, it is up to the designer to modify the system (often at his expense) in order to meet the requirements.

In practice, there is sometimes no formal acceptance procedure of the HVAC - systems by the owner. He simply trusts his design team and is not aware that this check is an important quality assurance procedure for the future operation and maintenance of his new building. This means then, that there is no process to insure that the designer has checked the fulfilment of the requirements of the HVAC equipment.

In practice, it is often left to the operator to detect and prove a lack of performance in the new equipment and to claim corrective actions when these defects are identified. Very often, these responsible persons are not professionals in Facility Management nor are they instructed to prevail the right of the owner. They cannot manage the situation and they are often not willing to admit this to their superior or to the management. In this situation, the owner, the management and/or the superior are not aware of the high risk that their HVAC-systems may run above the economic optimum point.

ENERGY EFFICIENCY IN ORDINARY OPERATION

In the national program Energy 2000, we had a subtask called "Optimum Operation of Complex Installations" (OCI). To develop appropriate tools for the market, we wanted to know why, in practice, the existing potential of energy savings by tuning the system and by best operation of complex installations are not realized. A short market study gave us very interesting information:

Personal contacts were established at the highest competence level for technical systems in:

- 16 medium-sized companies (50 - 500 employees)
- 19 large-sized companies (>500 employees).

Questions	Answers	
	Medium-sized companies	Large-sized companies
How is the Facility Management organized in your company?	62% FM competence or FM responsible in the management 38% no FM competence in the management	37% Energy supervisor in the top management and FM - Manager 48% FM Manager in the Management 15% no FM competence in the management
Estimate the existing potential for e-savings by tuning and best operation	Ø 15% min. 0% max. 30%	Ø 22% min. 10% max. 50%

Questions	Answers	
	Medium-sized companies	Large-sized companies
The necessary competence level for tuning and best operation is disposable in your company?	94% yes 6% no	52% yes 16% only partly 32% no
Why does your company not benefit from this potential?	• no time • cost-benefit ratio too low	• no time • lack of competence • no funds

These answers led us to the following conclusions:

- A considerable potential for energy savings in every complex HVAC -system, which could be realized by tuning and optimizing operation, is generally accepted. The effective potential is often highly underestimated.
- The internal competence for tuning and optimizing operation of the HVAC -systems is often overestimated. In these cases, it is much harder for external specialists to negotiate for support contracts in energy efficiency with the management.
- In most cases with a lack of internal competence, there were BEMS-controlled HVAC -systems. Operators and their superiors often expressed a wish to return to the old manual controlled systems.
- It is mainly not a technical reason, but rather a management and organization reason that the existing potential of energy savings by tuning the system and by best operation of complex installations are not realized.

The conclusion from this was the development of management tools and management seminars for the middle managers that are responsible for energy efficiency within the company. Very often, these people have no knowledge of how to proceed in projects for increasing energy efficiency, nor do they know how to successfully negotiate with the management for funds for these projects. The following tools were developed:

- Basic principles for optimum operation of complex installations (OCI)
- Cost-efficiency arguments for optimum operation of complex installations (OCI)
- Optimum operation – Sensitivity to the decision procedure

Based on experiences observed during these management seminars, the actual IEA annex 40 project of the Swiss shadow group is working to improve the competence of managers responsible for operation of the company buildings.

METHODIC APPROACH TO ENCREASE ENERGY EFFICIENCY IN ORDINARY OPERATION

In this project, basic principles are developed, for the business processes that are influencing energy consumption as well as their interfaces and the factors of influence in the life cycle of the building. The “competence of the facility manager” provides the fundamentals for implementing energy efficiency processes in companies. The sphere of activity and the actors involved provide the guidelines for these processes.

The actions of the owner, the facility manager (FM) and the tenant are market oriented. Service quality, costs, and terms are decisive factors. Considering these factors through the sphere of activities structured by change, risk, resources, and knowledge management provides a structure for tasks and workflow.

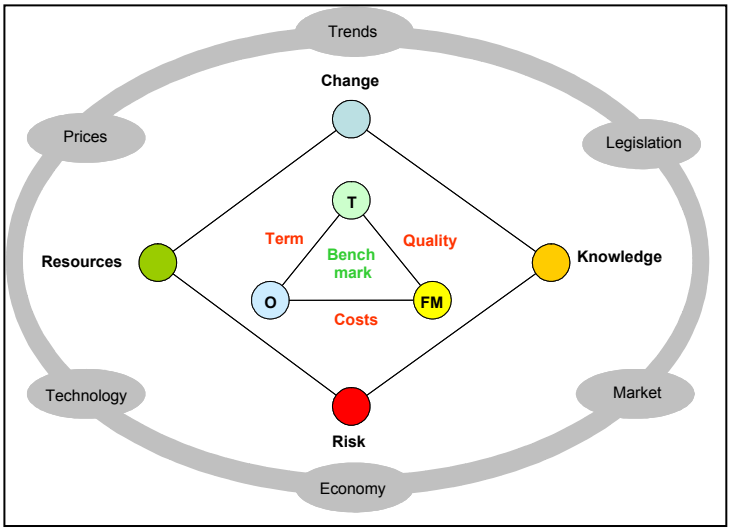

Figure 3. Market-oriented model of the actors, the sphere of activity, and the factors of influence.

The change, risk, resources, and knowledge management give the requirements of competence, which the FM must meet for a successful fulfilment of his task. It is important for him to not only consider each sphere, but also dependence and influence factors. Having analyzed these four spheres of activities and having implemented measures and priorities, the FM is prepared at any time to communicate the actual energy consumption in the company, to give its historic activity and to implement measures to influence it.

The FM acts in a complex environment between owner and tenant, external services and influence factors of the market. It is important for him to give a structure to his tasks and to his workflow. This leads to a process-oriented operation of the buildings.

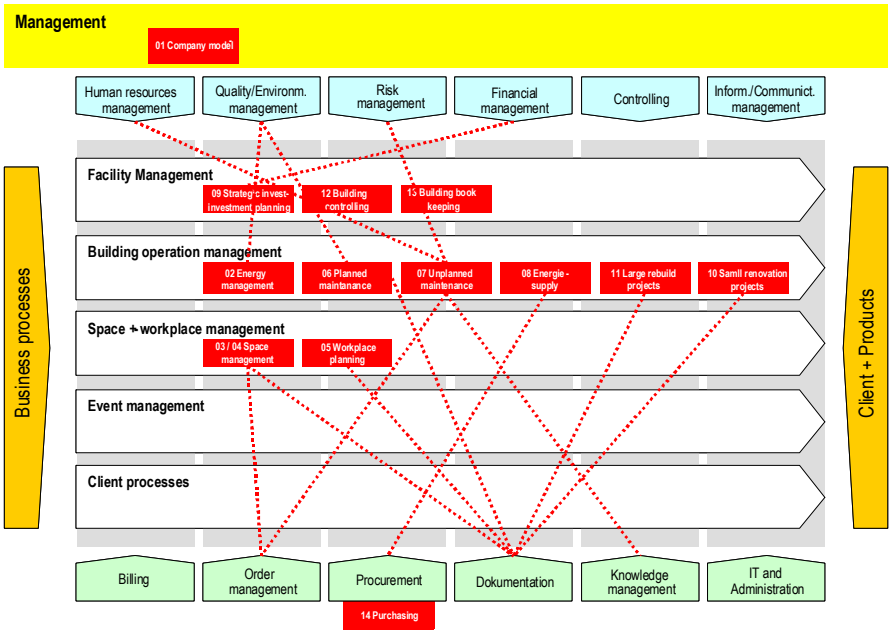

Figure 4. Model structuring the business processes of the FM having relevance for the energy efficiency (every commissioning activity in a company is part of the business process No. 2.)

Fourteen business processes in the FM's activities are relevant for energy efficiency (see figure No. 4). By analyzing each process from the point of view of the FM's sphere of activities (change, risk, resources and knowledge) and by detailed description (process flow), the relevant standards and operating performance can be determined and implemented in the daily business.

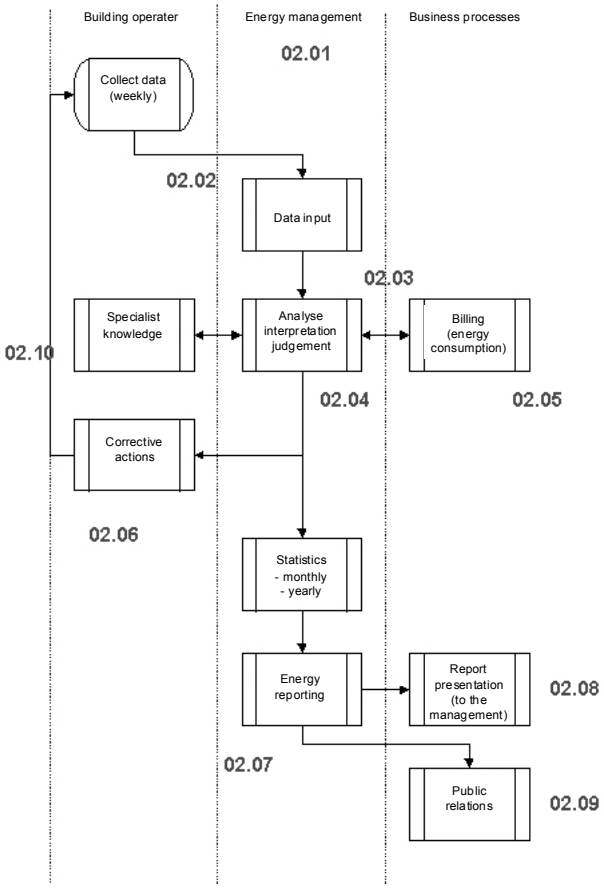

Figure 5. Example for business process No. 02, Energy management. For each process element a description of the activity and the responsible function must be given, with references to basic documents and tools.

The numbers in figure 5 are the risk elements in this business process. To analyse and judge the relevance of each risk element, the model according figure 3 can be used:

Risk	Risk description	Energy	Knowledge	Resources	Risk	Change	Remarks
02.01	The process is not existent in the company, or it is not carried out	+++	++	++	+++	+	
		No data acquisition operated. Missing basics for best operation	Transfer of knowledge needed. Which are the tools?	No responsible for this activity. Lack of resources	Systems may run above the economic optimum point	Missing synergetic effects to other processes (e.g. planned /unplanned maintenance)	▪ Basic process for benchmarking ▪ Detect potential of energy/costs
02.02	No appropriate tools, or data acquisition too expensive	++	+		+		
		Which are the relevant data? Revise the basic concept	Responsible persons are not professional. They are not instructed.		Actual energy report may be based on incorrect conclusions		▪ Definition of interface M-bus - BEMS - EM software ▪ Tools for data input (see 02.03)
02.03 02.04 02.05	Missing guidelines for data interpretation	++	++	+	+++	++	
		What is the purpose of the data analysing and interpretation?	Which are the target-values needed for the energy management? Who is giving the target?	Lack of knowledge in the FM management	The billing of energy consumption to the tenders may by based on incorrect conclusions	No motivation to reduce energy consumption by tenders	▪ Energy information system ▪ Tools for motivating in low energy consumption
02.06	Limited funds for corrective actions in the HVAC systems, low ROI	+++	+++	+++	++		
		Select corrective actions with high impact in energy efficiency and high ROI	Lack of knowledge in the FM staff	External support needed	External support may be too expensive. Problem of ROI		▪ Establish exact programme for measures with best cost/efficiency ratio

\+ ++ +++ low, middle or high relevance for the energy efficiency

Figure 6. Example how a business process can be analysed in its relevance for the energy efficiency

The result of the shadow group will be published in a manual in February 2005 with the following content:

- Theoretical background and its network
- Method and procedure
- Tools, examples and explanations for the practice

REFERENCES

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3. **SwissEnergy,** Optimum operation – Sensitivity to the decision procedure, EMDZ 805.220.2e, also published in the CD IEA Annex 40